TRUNK WINDOW TRAPPING: AN EFFECTIVE TECHNIQUE FOR SAMPLING TROPICAL SAPROXYLIC BEETLES

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Three techniques for trapping saproxylic (dead wood associated) beetles are compared, based on a study in an old-growth Australian lowland tropical rainforest. Trunk window traps, which are small flight intercept traps mounted on the sides of dead trees, are the most efficient, and are highly recommended for studies where high between-trap variability is not a major concern. Ground-based flight intercept traps collect fewer species, and sample a different, perhaps less substrate-specific, set of species. They are, however, useful for between-site comparisons since they have lower between-trap variability. Both techniques are cheap and simple to operate. Log emergence traps are the least efficient and their cost in time, effort and expense is high. They do, however, sample a few cryptic species not readily sampled by other means. All three techniques would be desirable for a comprehensive survey, but given time/cost constraints, trunk window traps alone are recommended. Despite a combined sampling intensity in this study equivalent to18 trap-years, the yield of 329 species from 59 traps may represent little more than half of the species potentially sampleable by these means. Thus whichever method is chosen, and whatever the objective, it is advisable to operate multiple traps continuously over several months during the season of insect activity. ❐ *saproxylic, Coleoptera, rainforest,Queensland, sampling, insect trap.*

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This paper compares a relatively new insect sampling technique, trunk window (TW) trapping, with the more established techniques using ground-based flight intercept (GFIT) and log emergence (LE) traps. All three techniques were used specifically to sample saproxylic beetles, as part of a wider investigation into the long-term impacts of logging in tropical rainforests on these organisms (to be reported elsewhere). The Daintree lowlands of northeast Queensland were chosen for this study since the region is relatively accessible, has a varied land-use history, and a fairly well-documented insect fauna (e.g. Monteith, 1985).

Saproxylic insects are those which depend on dead wood or wood-decaying fungi for at least part of their life cycle (Speight, 1989). They form a dominant functional group in any wooded environment. In temperate Europe, they are peculiarly sensitive to forest management, with many formerly common species now rare — some even regionally extinct — as a result of centuries of forest use and abuse (Kirby & Drake, 1993). Our understanding of forest ecosystems would suggest that much the same future awaits saproxylic insects wherever forests are subjected to heavy, long-term exploitation. However, there is currently no information available to support or refute this with regard to the world's tropical forests, where insect species richness is vast (Grove & Stork, 2000) and where exploitation rates seem set to escalate. There is thus a critical need for information on how forest management can be made ecologically sustainable, especially for saproxylic insects (Grove & Stork, 1999; Grove & Tucker, 2000).

MATERIALS AND METHODS

STUDY AREA. The research took place in the Daintree lowlands of northeast Queensland, a region with continuous lowland rainforest where areas of old-growth, logged and regrowth forest exist in relatively close proximity. Within this area, saproxylic beetles were sampled at nine sites differing in their management history. The sampling programmes described here refer to one of these, Thompson Creek (16°06'31"S 145°26'25"E), 4km south of Cape Tribulation on the northeasterly footslopes of Mount Lemmant, about 500m from the Australian Canopy Crane Facility. This site comprises old-growth, complex mesophyll vine forest 1a (Tracey & Webb, 1975), and lies at an altitude of 40-120m.

SAMPLING PROGRAMME. Sampling took place over the summers of 1997/98 and 1998/99. GFITs were placed every 50m along a 400m

'internal transect', making a total of 9 traps. The traps operated for about 17 weeks throughout the 1998 wet season, from January 10 to May 7. The following wet season, 26 TW traps and 24 LE traps were erected in the same area. The number of TW traps was limited by the availability of dead trees on which to mount them, while the number of LE traps was limited by cost and time constraints. The TW traps operated for about 8 weeks, from November 19 1998 until January 16 1999. Cyclone Rona destroyed most of them on February 11 1999, shortly before the next series of samples was due for collection. The LE traps operated for about 24 weeks, from November 19 1998 until May 5 1999, though several were destroyed by Cyclone Rona.

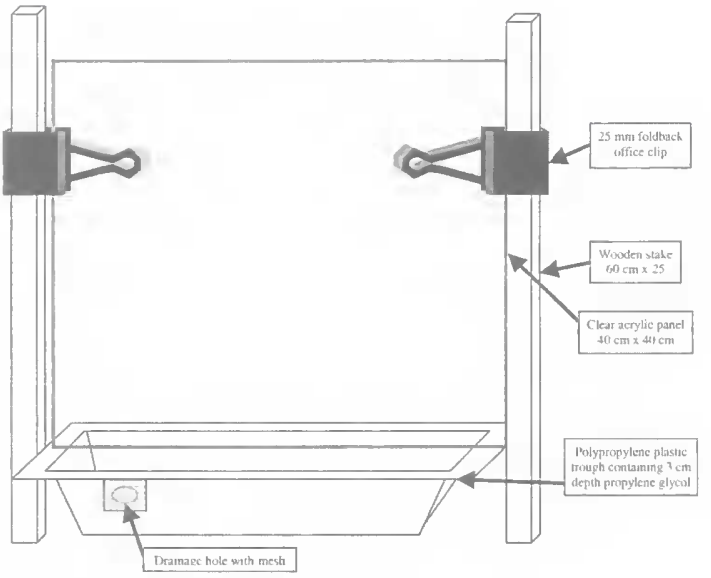

FIG. 1. Ground-based flight intercept trap.

TRAP DESIGN. *Ground-based Flight Intercept Traps*. Flight intercept traps consist of a vertical barrier to insect flight that is considered invisible to the insect. On hitting the barrier, most beetles drop down or attempt to circumvent the barrier by flying downwards. A collecting vessel placed beneath the barrier will catch many of these. GFITs have been widely used in Australia (e.g. Hill, 1993) since their first use in North America (Peck & Davies, 1980). The design used in this study (Fig. 1) is a scaled-down version of that regularly employed in the Wet Tropics by Monteith (pers. comm.). It consists of a 40cm square panel of 3mm clear acrylic clamped at each end with large foldback office clips to two vertical wooden stakes (25mm square section) driven into the ground. The acrylic panel is raised above the ground and its lower edge rests across the top of a 5 litre polypropylene ice-cream container (34cm long, 16cm wide, 12cm high) positioned on the ground lengthways between the two stakes. Propylene glycol is added to each container as collecting/preservative fluid. This is used in preference to ethylene glycol because of reduced vertebrate toxicity (Hall, 1991). The trap is protected from rain and debris by a roof of 0.2mm clear polythene rigged tentwise above it, such that the lower edges are no lower that the top of the acrylic panel. This roof is draped over a 1m high cord stretched lengthwise above the trap between two convenient trees and its four corners are tied with cord to nearby saplings, etc. Such a trap can operate for a month or more before the fluid needs augmenting. At clearing, the fluid is strained through a fine, nylon tea strainer and the catch transferred to 70% ethanol.

Trunk Window Traps. The concept of a flight intercept trap mounted above ground-level pre-dates that of GFITs (Chapman & Kinghorn, 1955). Aerial flight intercept traps have been further developed in Australia by Basset (1988) and Hill & Cermak, (1997). Kaila (1993) and Økland & Hågvar (1994) first employed flight intercept traps as TW traps specifically to sample saproxylic insects. The TW trap design used in this study applies their principles by modifying the standard GFIT so that it can be mounted on the side of a standing dead tree (Figs 2 & 3).

In the TW trap, the wooden support stake forms an inverted T-shape, the upright length being 45cm long and the cross-piece 15cm. A groove cut into the upright stake receives the acrylic panel. Three loose-fitting nails are fed through small holes in one side of the upright stake and lodge in similarly sized and spaced holes along one edge of the acrylic panel, thus holding the panel in place. The trap is anchored to the tree by an 8cm nail which passes through an angled hole in the top of the vertical stake and is hammered

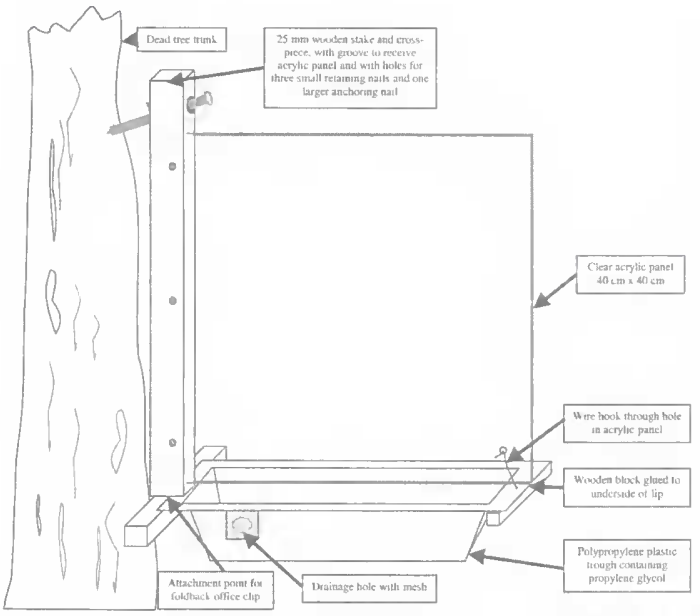

FIG. 2. Specifications of trunk window trap.

into the tree at head height. The corners of the lip of one end of the polypropylene container are clipped to the cross-piece using two foldback office clips. The other end is attached to the outer corner of the acrylic panel with a piece of wire, the bent tip of which feeds into a small hole near its corner. The container can readily be removed for emptying by unclipping the wire and clips. A roof of polythene sheeting is rigged up above the trap, again using cord tied at four corners and with a main taut 'strut' running along the axis of the trap from the tree-trunk to a nearby tree. To divert water running down the tree-trunk, the polythene is affixed to the tree at key points using small nails and plastic washers. Preservative and service procedures are as described for the ground-based FIT.

Log Emergence Traps. The LE (Fig. 4) is a modified version of one described by Owen (1989). It consists of an enclosed tent-like structure into which a standard volume ($0.5m^3$) of sawn-up dead wood derived from the target log is placed. Emerging insects head towards the light, where their only exit is through two tubes in the topmost corners of the tent, leading into collecting jars. The main tent material is black spun polypropylene mulch-matting, as recommended by Uffen (1998), with pore-size smaller than the smallest beetle. It has the advantage over other materials of maintaining the microclimate inside similar to outside, since it is permeable to air and moisture. The final trap dimensions are roughly 150cm long, 80cm wide, and 80cm high. Wood is inserted or removed by means of a sealable opening secured by velcro strips along one of the lower lengths of the trap and one of the adjacent sides; all other seams are permanently sewn closed. A sheet of polypropylene plastic laid on the ground beforehand reduces damage by roots, small mammals and soil-living invertebrates such as termites. The trap is kept in shape by guying to a wooden stake at each end. A collecting head at

FIG. 3. Trunk window trap, in situ.

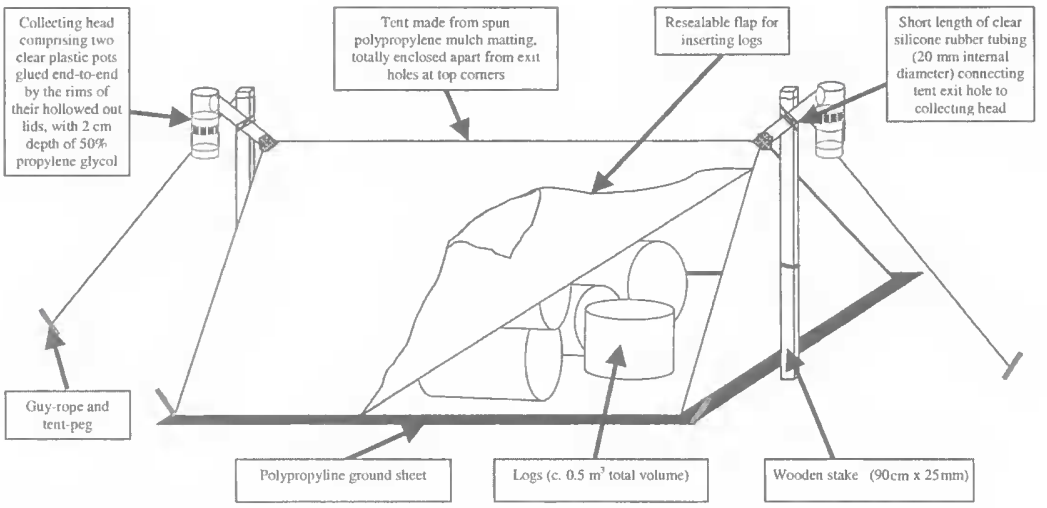

FIG. 4. Log emergence trap.

each end comprises a clear plastic funnel glued into the top corner of the main tent, connected by a short length of 20mm diameter silicone rubber tubing to an inverted 300ml plastic specimen jar, via a hole near its base (i.e. the top). A second specimen jar, fitted below this and attached by the rims of two jar lids glued back-to-back, serves as the collecting vessel, using 50% propylene glycol as the collecting and preserving fluid. The trap can operate for a month or more at a time; the lower jar is then unscrewed and replaced with a new one.

SPECIES IDENTIFICATION. Potentially saproxylic beetles were removed from the samples and initially identified to the level of morphospecies (Oliver & Beattie, 1996). Beetles were regarded as saproxylic if so suggested by their habitat associations recorded in the literature or during this study. Most Staphylinoidea, Nitidulidae and a few other difficult or poorly known groups were discounted since they were considered taxonomically intractable and/or their status as saproxylic beetles could not be ascertained. For the remainder, identification to family and sub-family level was readily accomplished using standard works (Lawrence & Britton, 1994). Tentative identification to species proved feasible for only about a third of these. Key publications include Slipinski (1988); Slipinski & Lawrence (1997); Calder, (1996); Matthews (1984, 1985, 1987, 1992); Zimmerman (1991, 1992, 1993a, 1993b, 1994) and Dibb (1938). Many species were identified with the help of other entomologists in Australia and overseas. Voucher specimens are lodged at the Queensland Museum (Brisbane), James Cook University (Cairns), Department of Primary Industries (Mareeba) and the Australian National Insect Collection (Canberra).

STATISTICAL ANALYSIS. Species diversity and community similarity statistics were calculated using the computer programs EstimateS (Colwell, 1997) and PC-ORD (McCune & Mefford, 1999).

RESULTS

The combined sampling intensity from all 59 traps represents the equivalent of 18 trap-years. Together, the three techniques produced 3399 specimens belonging to 329 species or morphospecies (Appendix 1). Table 1 gives some species richness and compositional attributes for the three techniques.

GENERAL TRAPPING EFFICIENCY. The three techniques differ markedly in the total numbers of species sampled, although the differences in sampling intensity and duration must be borne in mind. At the level of sampling effort used, TW traps fare best, with 233 species, representing 71% of the total species list sampled. LE traps sample 137 species (42%), while GFITs perform least well with 127 species (39%). When species richness is standardised to 9 traps using the Coleman richness expectation (based on a process similar to rarefaction

TABLE 1. Species richness and compositional attributes for trunk window (TW), log emergence (LE) and ground-based flight intercept (GFIT) trap sampling programmes at Thompson Creek. N = 329 species.

	TW (N = 26)	LE (N = 24)	GFIT (N = 9)
Total no. of species	233	137	127
No. of species as percentage of grand total	71	42	39
Coleman richness expectation for 9 random traps	142	85	127
Coleman richness expectation for 9 random traps as percentage of grand total	43	26	39
Mean no. of species per trap	8.6	5.7	14.1
Mean no. of species per trap-week	1.1	0.2	0.8
% of species represented by singletons	46	46	56
Abundance-based Coverage Estimator (ACE)	411	225	228
No. of species as percentage of ACE	57	61	56
No. of species unique to sampling technique	111	23	39
Multi-Response Permutation Procedures average Euclidean distance amongst samples	3.1	2.2	2.8

[Coleman, 1981]), TW traps still perform best (142 species, or 43% of the total species sampled), GFITs are not far behind (127 species or 39%), while LE traps perform much less well (85 species or 26%). Standardising to one trap suggests that GFITs perform best (14.1 species per trap compared to 8.6 for TW and 5.7 for LE). However, GFITs were sampling for much longer than TW traps. When different sampling durations are taken into account by standardising to one trap-week, TW traps perform best (1.1 species per trap-week) compared to 0.8 for GFIT and only 0.2 for LE. This is perhaps an unfair comparison since it does not take into account different intrinsic rates of species accumulation and between-trap heterogeneity, especially for LE traps since they sample the fauna present in dead wood at the time that the trap was erected, with no opportunity for colonisation by further species.

Randomised species accumulation curves (Fig. 5) suggest that no technique is yet close to capturing the full range of sampleable species. A large proportion of species in all three techniques occur as singletons, ranging from 46% for TW and LE traps to 56% for ground-based FITs. This suggests that there are many more species that have yet to be sampled because of their rarity or their cryptic nature. Many statistical methods exist to estimate total species richness by extrapolating from these curves or their underlying data. A recently devised and promising statistic is the abundance-based coverage estimator (ACE, Chao, Ma & Yang, 1993; Chazdon, 1996). ACE predicts notional 'total' species richness attainable using 24 TW traps as 411 species (suggesting 57% coverage so far), a much higher number than predicted to be attainable using either 26 LE traps (225 species or 61% so far), or 9 GFITs (228 species or 56% so far).

TRAP SELECTIVITY. The degree to which the different techniques overlap in the species they sample offers further insight into their effectiveness. TW traps again fare best, with 111 species not caught by other techniques. This compares with just 39 species caught only in GFITs and a mere 23 caught only in LE traps. In terms of overall similarity in species composition, a principal components analysis (PCA, Fig. 6) shows that the three techniques are largely separable by the assemblages of species they sample, so all are selective to some extent. There is a small amount of overlap between some TW and LE trap samples, while GFIT samples occupy a completely separate part of the ordination space.

TRAP SAMPLE HETEROGENEITY. Within-technique heterogeneity was investigated using the Multi-Response Permutation Procedures (MRPP) running in PC-ORD, employing the recommended Euclidean distance measure and n/sum (n) weighting of groups. MRPP is a non-parametric procedure whose primary use is for testing the hypothesis of no difference between two or more groups of entities (in this case sampling techniques). Of particular use here is that MRPP also reports the average Euclidean distance between members of each group. For TW, this is 3.1, for LE 2.2 and for GFIT 2.8. In other words, TW samples are the most heterogeneous (high between-trap variability), LE samples the most homogeneous (low between-trap variability), and GFIT samples intermediate.

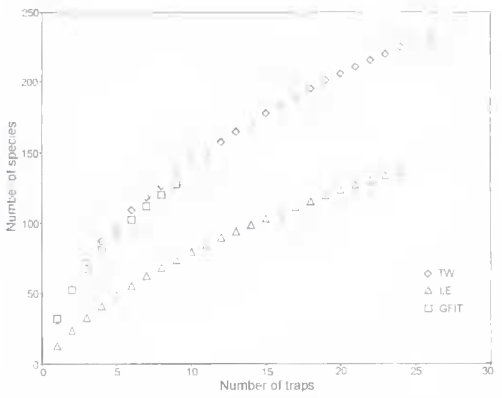

FIG. 5. Randomised species accumulation curves for the three sampling techniques, based on total number of traps at Thompson Creek. Note that different techniques used different numbers of traps: 26 for trunk window (TW); 24 for log emergence (LE); 9 for ground-based flight intercept traps (GFIT). Note also that the curves do not provide a direct measure of trap efficiency since individual traps in different techniques were sampling for different lengths of time.

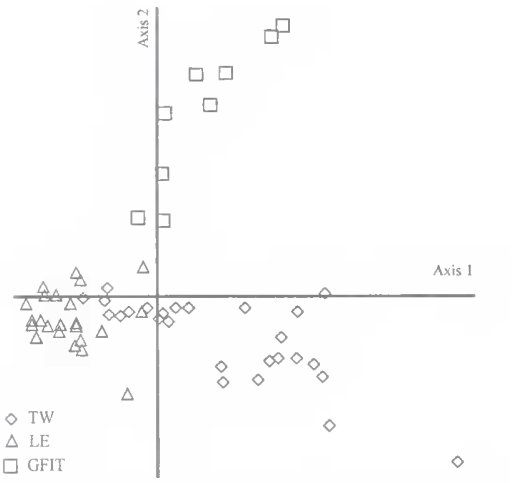

FIG. 6. Ordination plot (first two axes) from a principal components analysis (variance-covariance, on $\log_{10}+1$ transformed abundance data) of saproxylic beetles sampled using trunk window (TW), log emergence (LE) and ground-based flight intercept (GFIT) traps at Thompson Creek. N = 329 species.

DISCUSSION

Trapping efficiency is a key consideration for most types of insect survey (Muirhead-Thomson, 1991). The definition of efficiency depends on the objective of the study. Where the aim is to collect as many species as possible, as efficiently as possible, the best strategy is to select a technique, or combination of techniques, that targets the species in question. Where the aim is to compare two or more sites on the basis of their species composition, it is more important that sampling effort be standardised. For both these objectives, time and money are always further considerations. Given these considerations, how do the three sampling techniques compare?

TW traps are cheap, simple and robust under normal (non-cyclone) rainforest conditions. They are very efficient at sampling saproxylic beetles when mounted on standing dead tree trunks as in this study. Each trap produces more species than either of the other techniques, and the rate at which species accumulate with successive traps is also higher, with little indication of reaching an asymptote even with 24 such traps in operation over eight weeks. Many species are caught by this technique but not by the others at comparable sampling intensities. The species composition of TW trap samples varies more than other techniques, but is generally more similar to that of LE trap samples than GFITs. This suggests that they are effective at sampling the fauna of the dead standing trees on which they are mounted. All these attributes imply that TW traps represent a valuable technique for sampling saproxylic beetles where the objective of study is either a thorough species inventory or a comparison of different substrates (e.g. dead trees versus living trees, or trees with shelf-fungi versus trees without shelf-fungi). However, this substrate specificity and the high rate of species accumulation also makes the design less suitable for a comparison of sites, since it would be difficult to standardise the location of traps unless a sufficiently large pool of dead standing trees were available at each site.

GFITs are cheap to produce, easy to operate and durable under rainforest conditions. Unfortunately, they are not especially efficient at sampling saproxylic beetles — at least, not in the design used in this study. Not only do they catch fewer species per trap than TW traps, but the rate at which successive traps accumulate more species is also slightly lower, and rather few of these species are not caught by other techniques. Those species which are uniquely caught by GFITs may include less substrate-specific species — which may account for their absence

in other sample types. On the other hand, many studies show that GFITs sample insects from a wide area and are relatively immune to the effects of habitat patchiness in their immediate vicinity (Siitonen, 1994; Økland, 1996) — perhaps picking up species dispersing from one habitat patch to another. Coupled with the fact that between-trap heterogeneity is lower than TW traps, this makes them suitable for studies where the objective is to compare between sites using multiple traps per site.

Log emergence traps are expensive to make, time-consuming to erect and stock with logs, and have relatively short life under rainforest conditions. They sample relatively few species per trap, and few of these are not sampleable by other techniques. Thus log emergence traps cannot be recommended as a standard sampling technique. They may still have a useful role if time and money are not limiting, and if the objective of the study is either a thorough species inventory or to determine which species occur in clearly delimited substrates.

It is clear that no single technique will adequately sample the entire saproxylic fauna, but trunk window traps come closest to doing so and represent a sampling option that deserves wider consideration. Even so, it is evident that, in tropical forests at least, large numbers of traps would be required over several months or years to reach species saturation.

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APPENDIX 1

Species list for saproxylic beetles at Thompson Creek, from the three sampling techniques. GFIT = Ground-based flight intercept trap; LE = Log emergence trap; TW = Trunk window trap.

Species	GFIT	LE	TW
RHYSODIDAE			
Kaveinga abbreviata (Lea, 1904)	0	0	7
Kaveinga frontalis (Grouvelle, 1903)	1	5	7
Rhyzodiastes mirabilis (Lea, 1904)	11	16	3
CARABIDAE			
Ametroglossus ater (Macleay, 1887)	0	0	1
Pogonoglossus 'sp. nov. 01'	1	1	2
Perigona rufilabris (Macleay, 1871)	5	3	3
Dolichoctis striata Schmidt-Goebel, 1846	1	0	1
Distipsidera flavipes Macleay, 1887	1	0	1
Distipsidera parva Macleay, 1887	1	0	4

Species	GFIT	LE	TW
HISTERIDAE			
Platylomalus terrareginae (Blackburn, 1903)	5	4	2
Platylomalus saucius (Blackburn, 1903)	1	0	0
Platysoma sp. agg. 01	3	0	37
STAPHYLINIDAE			
Priochirus miles Bernhauer	8	9	0
SCIRTIDAE			
Scirtidae sp. 01	0	5	0
Prionocyphon sp. 01	0	0	1
LUCANIDAE			
Prosopocoilus torresensis (Deyrolle, 1870)	0	0	8

Species	GFIT	LE	TW
PASSALIDAE			
Aulacocyclus fracticornis Kuwert, 1891	7	26	8
Mastachilus australasicus (Percheron, 1841)	2	4	3
CERATOCANTHIDAE			
Pterorthochaetes simplex (Gestro, 1899)	1	1	12
SCARABAEIDAE			
Australoxenella concinna Storey & Howden, 1996	2	0	1
Daintreeola grovei Storey & Howden	0	0	3
Glycyphana pusilla Bacchus, 1974	0	1	0
Ischiopsopha wallacei (Thomson, 1860)	0	0	5
CALLIRHIPIDAE			
Ennometes sp. 01	0	0	5
Ennometes sp. 02	0	0	1
PTILODACTYLIDAE			
Ptilodactyla sp. 01	116	12	25
Ptilodactyla sp. 02	54	37	12
CHELONARIIDAE			
Chelonarium australicum Lea, 1918	0	0	1
EUCNEMIDAE			
Melanoscython sp. 01	1	0	0
Fornax sp. 01	0	4	1
Fornax sp. 02	0	1	1
Microrhagus sp. 01	0	1	1
Microrhagus sp. 02	0	0	1
Microrhagus sp. 03	0	0	1
Microrhagus sp. 04	1	1	0
Microrhagus sp. 05	2	0	1
Agalba sp. 01	0	0	1
Agalba sp. 02	0	0	1
Galbodema mannerheimi LaPorte, 1835	0	3	0
Dromaeoloides sp. 01	0	1	0
Euryptychus sp. 01	0	0	3
Euryptychus sp. 02	1	0	0
Dromaeolus sp. 01	0	0	1
Rhagomicrus sp. 01	0	0	1
Eucnemidae gen. nov. sp. 01	0	0	1
Hemiopsida sp. 01	1	0	0
THROSCIDAE			
Throscidae sp. 01	0	0	1
Potergus sp. 01	0	0	3
Aulonothroscus sp. 01	0	3	0
ELATERIDAE			
Elateridae sp. 03	17	2	3
Agrypnus sp. 01	10	3	5
Anilicus 'sp. nov.'	0	0	2
Megapenthes sp. 01	1	0	3
Megapenthes sp. 02	4	0	2

Species	GFIT	LE	TW
ELATERIDAE (cont.)			
Megapenthes sp. 03	2	3	1
Melanoxanthus sp. 01	9	24	8
Melanoxanthus sp. 03	0	0	1
Melanoxanthus sp. 06	1	0	2
Melanoxanthus sp. 07	0	0	2
Cardiotarsus sp. 01	1	0	0
Cardiotarsus sp. 02	0	0	1
Paracardiophorus sp. 01	20	0	1
Paracardiophorus sp. 02	14	0	1
LYCIDAE			
Trichalus sp. 01	1	2	0
Trichalus sp. 02	4	6	0
Trichalus ater (Macleay, 1887)	1	1	0
Cladophorus sp. 01?	0	1	0
Xylobanus (?*Stadenus*) *ampliatus* Macleay, 1887	2	3	0
CANTHARIDAE			
Sphaerarthrum rubriceps (Macleay, 1887)	0	1	0
Heteromastix sp. 01	8	14	0
Heteromastix sp. 02	0	1	0
JACOBSONIIDAE			
Gonya sp. 01	0	0	1
Sarothrias lawrencei Lobl & Burckhardt, 1988	3	2	28
NOSODENDRIDAE			
Nosodendron interruptum (Lea, 1931)?	1	0	18
ANOBIIDAE			
Pronus sp. 01	0	1	0
Mysticephala sp. 01	0	0	9
TROGOSSITIDAE			
Larinotus umbilicatus (Carter & Zeck, 1937)	0	0	2
Neaspis sp. 01	0	1	0
CLERIDAE			
Ommadius yorkensis Kuwano	0	3	0
Ommadius sp. 03	0	0	1
Isoclerus gerstmeieri Kolibac, 1998	0	0	1
MELYRIDAE			
*Carphurus armipennis*Fairmaire, 1879	0	0	1
SPHINDIDAE			
Aspidiphorus sp. 01	10	4	82
NITIDULIDAE			
Brachypeplus caudalis Murray	14	1	1
MONOTOMIDAE			
Mimemodes laticeps Macleay	0	1	3
Mimemodes sp. 01	0	1	0
Shoguna termitiformis Fairmaire	7	7	11
SILVANIDAE			
Psammoecus 'ANIC sp. 01'	3	1	1
Monanus 'ANIC sp. 01'	1	0	1

Species	GFIT	LE	TW
LAEMOPHLOEIDAE			
Laemophloeidae sp. 03	1	0	0
Laemophloeidae sp. 04	0	0	1
Laemophloeidae sp. 05	0	0	4
Microlaemus brightensis (Blackburn)	0	0	3
Laemophloeus sp. 01	3	0	2
Mariolaemus sp. 01?	1	1	0
Rhabdophloeus conterminus (Olliff)	0	0	1
Xylolestes ovalis (Grouvelle)?	1	0	1
PROPALTICIDAE			
Propalticus simplex Crowson & Sen Gupta, 1969	0	0	3
PHALACRIDAE			
Phalacridae sp. 01	5	0	3
CRYPTOPHAGIDAE			
Microatomaria hintoni Leschen, 1996	2	2	1
EROTYLIDAE			
Microsternus sp. 01	0	0	1
Episcaphula sp. 01	0	0	1
BIPHYLLIDAE			
Biphyllus obscuronotatus (Lea, 1922)	11	2	23
Biphyllus ornatellus Blackburn	0	0	2
BOTHRIDERIDAE			
Teredolaemus sp. 02	1	1	0
CERYLONIDAE			
Australiorylon neboissi Slipinski, 1988	42	1	34
Australiorylon setosus Slipinski, 1988	8	0	8
Cautomus mirabilis (Oke, 1932)	3	0	5
Cerylonopsis doyeni Slipinski, 1988	0	0	21
Lapethus astrolabei Heinze, 1944	3	2	6
Philothermus microsetosus Slipinski, 1988	41	4	31
Euxestus matthewsi Slipinski, 1988	15	3	27
DISCOLOMATIDAE			
Aphanocephalus sp. 01	2	25	44
Aphanocephalus poropterus Lea, 1922?	1	0	1
ENDOMYCHIDAE			
Endomychidae sp. 01	1	2	0
Endomychidae sp. 03	0	0	57
Endomychidae sp. 04	0	1	1
Endomychidae sp. 05	1	1	0
Endomychidae sp. 06	0	0	1
Erotendomychus n. sp. 01	0	1	0
Idiophyes brevis Blackburn, 1895?	0	0	3
Stenotarsus pisoniae Lea	4	3	6
COCCINELLIDAE			
Coccinellidae sp. 01	1	1	0
Coccinellidae sp. 02	0	1	0
Coccinellidae sp. 03	0	1	0
Sticholotidinae sp. 01	1	3	3
Telsimia sp. 01	1	1	0

Species	GFIT	LE	TW
CORYLOPHIDAE			
Holopsis sp. 02	0	0	15
Holopsis sp. 03	3	1	2
Parmulus sp. 01	98	21	45
Parmulus sp. 02	1	1	0
LATRIDIIDAE			
Bicava castanea (Broun)	0	0	2
Bicava sp. 01	9	0	21
Bicava sp. 02	5	0	39
Aridius sp. 01	3	0	0
CIIDAE			
Octotemnus sp. 01?	0	0	1
Octotemnus sp. 02	0	0	1
Cis sp. 01	14	12	123
Cis sp. 02	4	0	6
Cis sp. 03	5	4	20
Cis sp. 04	0	0	2
Cis sp. 05	2	0	0
Cis sp. 06	0	0	1
Cis sp. 07	1	0	1
Cis sp. 09	0	0	1
Cis sp. 10	2	0	0
Cis 'sp. 886'	1	1	2
Euxestocis sp. 01	0	0	125
Neoennearthron sp. 01	2	2	0
Orthocis sp. 01	0	0	3
Orthocis sp. 02	0	0	4
MELANDRYIDAE			
Orchesia sp. 01	1	0	0
MORDELLIDAE			
Mordellidae sp. 01	4	0	6
Mordellidae sp. 02	0	0	1
Mordellidae sp. 03	0	0	1
Mordellidae sp. 04	0	0	2
Mordellidae sp. 07	1	0	0
Mordellidae sp. 11	0	0	1
Mordellidae sp. 12	0	1	0
Mordellistena coelioxys Lea?	9	1	11
Plesitomoxia 'ANIC sp. 03'	1	0	0
ZOPHERIDAE			
Ablabus queenslandicus Slipinski	1	2	1
Antilissus sp. 01	0	0	1
Colobicones alfa Slipinski, 1999	2	1	1
Colobicones australis Slipinski, 1999	4	0	2
Colobicones oculatus Slipinski, 1999	5	0	19
Colobicones papuanus Slipinski?	1	0	0
Pseudendestes australis Lawrence, 1980	2	6	1
Tentablabus fulvus Slipinski & Lawrence, 1997	0	0	2
Synchita ?fasciata (Carter & Zeck, 1937)	1	0	0
Pycnomerus 'n. sp.' 01	3	0	27

Species	GFIT	LE	TW
TENEBRIONIDAE			
Dimorphochilus flavicornis (Macleay)	1	0	1
Alleculinae sp. 01	0	0	1
Hypaulax tenuistriata Bates, 1874	1	1	0
Promethis carteri Kaszab	0	0	1
Chariotheca doddi Carter, 1924	0	0	1
Chariotheca planicollis (Fairmaire, 1849)	0	0	1
Ceropria maculata Gebian, 1911	0	0	1
Corticeus sp. 02	1	1	0
Menimus sp. 01	9	9	74
Menimus sp. 02	0	1	2
Menimus neboissi Kaszab?	23	21	13
Platydema sp. 01	0	2	14
Platydema sp. 02	2	2	6
Archaeoglenes australis Doyen & Lawrence, 1979	1	0	0
Pseudophthora wilsoni Kaszab, 1978	0	0	1
Dioedus sp. 01	0	0	2
Dioedus sp. 02	0	1	1
Asphalus rectibasis (Carter, 1914)	0	0	1
Byrsax pinnaticollis Carter, 1914	0	0	10
Mychestes sp. 01	1	1	0
Paraphanes nitidus Macleay, 1888	0	0	3
Rhipidandrus simsoni Waterhouse, 1894	0	0	6
Uloma sanguinipes (Fabricius, 1775)	0	3	0
Uloma westwoodi Pascoe, 1863	0	0	1
PYROCHROIDAE			
Morpholycus flabellicornis (Macleay, 1887)	5	5	0
ANTHICIDAE			
Lemodes caeruleiventris Blair, 1913?	0	7	2
Tomoderus tricoloricornis (Lea)	4	2	13
Tomoderus sp. 01	1	1	0
Pseudotomerus sp. 01	1	0	0
ADERIDAE			
Aderidae sp. 01	1	0	1
Aderidae sp. 02	2	8	20
Aderidae sp. 03	0	0	1
Aderidae sp. 05	0	0	2
Aderidae sp. 07	1	0	0
Aderidae sp. 10	15	0	1
SCRAPTIIDAE			
Scraptia sp. 02	0	0	1
CERAMBYCIDAE			
Ceresium sp. 01	1	1	0
Lamiinae sp. 01	6	6	0
Lamiinae sp. 02	1	0	0
Dihammus (Acalolepta) argentatus (Aurivillius)	2	4	0

Species	GFIT	LE	TW
ADERIDAE (cont.)			
Dihammus (Acalolepta) aestheticus (Olliff)	0	1	0
Disterna mastersi (Pascoe)?	0	0	1
Cyocyphax praonethoides Thomson, 1878	0	1	0
Somatidia sp. 02	1	0	0
Aesa sp. 01	0	0	1
Archetypus fulvipennis (Pascoe)	0	1	0
ANTHRIBIDAE			
Araeocerodes sp. 01	4	0	5
Araeocerodes sp. 03	0	0	1
Araeocerodes sp. 04	0	1	1
Araeocerodes sp. 05	0	1	12
Misthosima 'new species 01'	0	0	2
Stenorhis 'new species 03'	0	0	4
Anthribinae sp. 02	0	0	1
Anthribinae sp. 06	1	0	0
Anthribinae 'genus P new sp. 01'	4	4	0
Basitropis relicta Blackburn, 1900	1	1	0
Commista latifrons Jordon, 1895	2	2	0
Eupanteos ornatus Jordan, 1923	0	0	1
Mauia subnotatus (Boheman, 1859)	0	0	1
Mauia sp. 01	0	0	1
Notoecia reticulata Blackburn, 1900	3	3	1
BRENTIDAE			
Brentinae sp. 03	1	1	0
Ectocemus decemmaculatus (Montrouzier, 1855)	1	0	0
Brentinae 'Qld genus C' sp. 01	1	0	2
Cordus 'new species 5'	0	0	1
Ithystenus hollandiae (Boisduval, 1835)	17	16	1
Mesoderes guttatus (Kleine, 1916)	0	1	1
CURCULIONIDAE			
Eutinophaea variegata Lea, 1904?	1	16	30
Cossoninae sp. 01	2	0	0
Cossoninae sp. 02	0	0	1
Cossoninae sp. 04	1	0	0
Cossoninae sp. 05	0	0	1
Cossoninae sp. 06	1	0	0
Cossoninae sp. 08	0	3	1
Cossoninae sp. 10	3	0	4
Cossoninae sp. 11	2	8	18
Cossoninae sp. 12	0	0	1
Cossoninae sp. 14	0	0	1
Cossoninae sp. 15	0	0	1
Cossoninae sp. 16	1	0	4
Cossoninae sp. 18	0	3	1
Cossoninae sp. 20	1	1	0
Cossoninae sp. 21	0	1	0

Species	GFIT	LE	TW
CURCULIONIDAE (cont.)			
Cossonus sp. 02	1	0	0
Cossonus nigroapicalis Lea, 1909	0	1	3
Cryptorhynchinae sp. 01	15	0	1
Cryptorhynchinae sp. 03	4	3	0
Cryptorhynchinae sp. 04	3	0	1
Cryptorhynchinae sp. 05	1	0	0
Cryptorhynchinae sp. 06	0	0	1
Cryptorhynchinae sp. 08	1	0	0
Cryptorhynchinae sp. 10	3	0	0
Cryptorhynchinae sp. 12	6	17	21
Cryptorhynchinae sp. 14	0	0	1
Cryptorhynchinae sp. 15	17	32	55
Cryptorhynchinae sp. 16	19	30	86
Cryptorhynchinae sp. 24	0	1	3
Cryptorhynchinae sp. 25	2	3	1
Cryptorhynchinae sp. 26	3	2	0
Cryptorhynchinae sp. 29	2	1	0
Cryptorhynchinae sp. 31	1	0	0
Cryptorhynchinae sp. 32	0	1	0
Cryptorhynchinae sp. 33	0	0	2
Cryptorhynchinae sp. 35	1	1	0
Cryptorhynchinae sp. 36	0	0	1
Cryptorhynchinae sp. 37	29	35	6
Cryptorhynchinae sp. 38	0	0	3
Cryptorhynchinae sp. 40	2	0	0
Cryptorhynchinae sp. 41	1	0	0
Cryptorhynchinae sp. 43	0	0	3
Cryptorhynchinae sp. 45	0	0	1
Cryptorhynchinae sp. 48	0	0	1
Cryptorhynchinae sp. 51	1	1	1
Cryptorhynchinae sp. 52	0	0	4
Cryptorhynchinae sp. 54	0	1	0
Cryptorhynchinae sp. 55	0	0	1
Cryptorhynchinae sp. 56	0	0	1
Mormosintes rubus Pascoe, 1865?	2	2	5
Acrotychreus sp. 01	1	0	0
Anchithyrus caliginosus Lea, 1912?	1	4	20
Austrectopsis oblonga Lea, 1912	0	0	1

Species	GFIT	LE	TW
CURCULIONIDAE (cont.)			
Dysopirhinus grandis Lea, 1903	0	6	1
Imaliodes ovipennis Lea, 1912	0	0	1
Mechistocerus cancellatus Lea, 1909	10	36	11
Nechyrus sp. 01	1	0	0
Nechyrus mollipes Lea, 1907	2	2	0
Trigonopterus albidosparsa (Lea, 1912)	0	1	1
Tyrtaeosus brevirostris Lea, 1913	1	1	5
Psepholacini sp. 01	0	0	1
Crossotarsus nitescens Schedl, 1979?	1	0	0
Diapus pusillimus Chapuis, 1865	3	3	3
Treptoplatypus australis (Chapuis, 1865)	0	0	1
Platypus queenslandi Schedl	0	0	7
Platypus carbonescens (Beeson)?	0	46	2
Scolytinae sp. 03	2	0	0
Scolytinae sp. 05	0	0	1
Scolytinae sp. 07	0	0	1
Scolytinae sp. 08	0	0	3
Scolytinae sp. 09	0	0	1
Scolytinae sp. 10	0	0	1
Scolytinae sp. 11	1	0	0
Scolytinae sp. 14	0	0	1
Scolytinae sp. 16	0	0	48
Scolytinae sp. 20	3	0	0
Xyleborus sp. 02	5	0	6
Xyleborus sp. 03	2	0	1
Xyleborus insulindicus Eggers, 1923	2	0	9
Xyleborus similis Ferrari, 1867	14	16	138
Xyleborus perforans (Wollaston, 1857)?	6	1	11
Xyleborus ferrugineus (Fabricius)	1	1	13
Xylosandrus morigerus (Blandford, 1894)	2	0	0
Hypothenemus eruditus Westwood, 1836	1	0	2
Euwallacea fornicatus (Eichhoff)	12	0	35
Euwallacea wallacei (Schedl)	1	0	6
Mecopus pictus Lea, 1910	1	1	0
Dryophthoroides sp. 01	0	0	7
Dryophthorus sp. 01	4	0	0